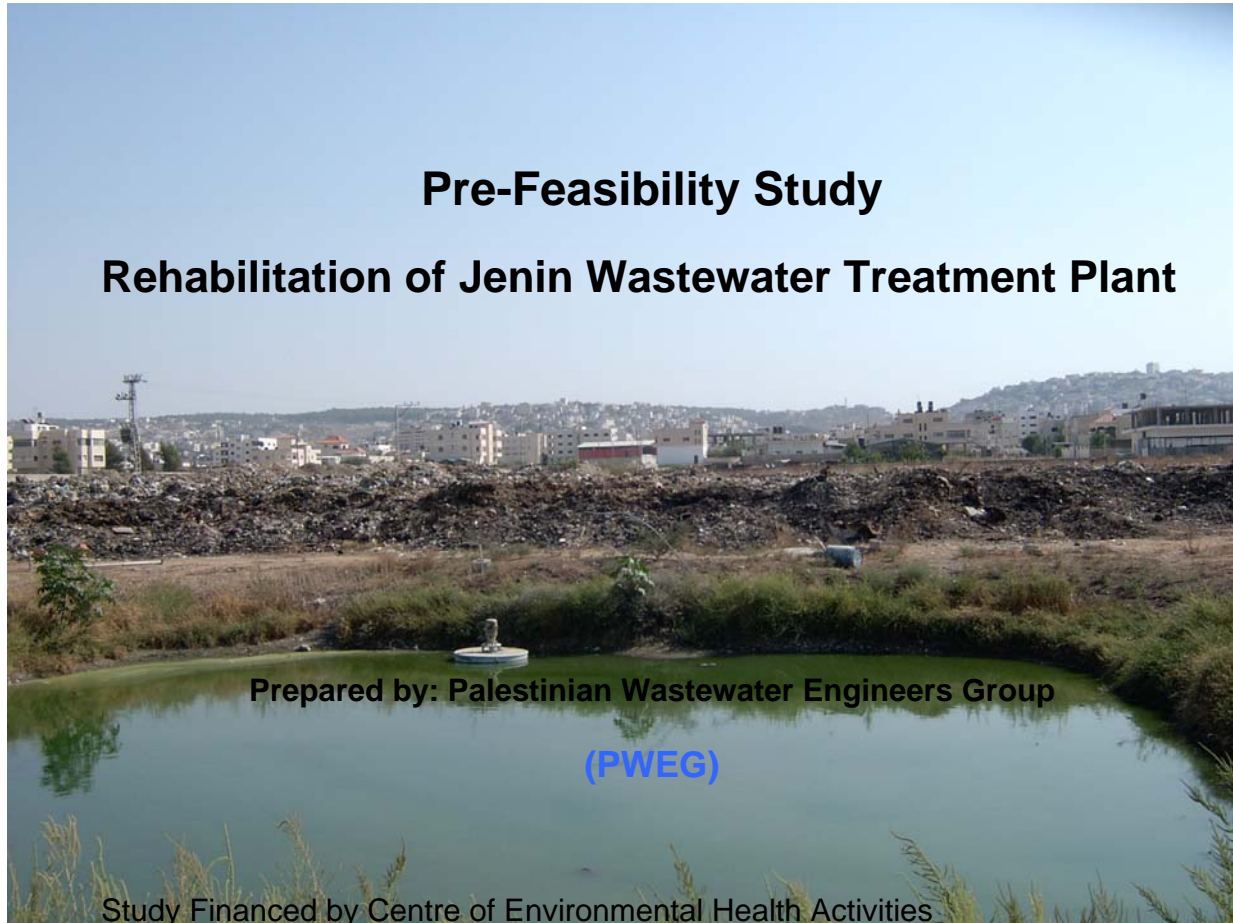
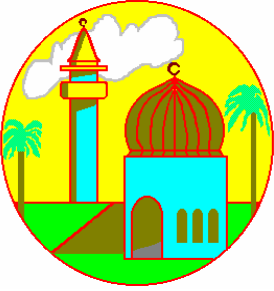


بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Palestinian National Authority

Jenin Municipality

Palestinian Wastewater Engineers Group



Pre-Feasibility Study

Rehabilitation of Jenin Wastewater Treatment Plant

Prepared by: Palestinian Wastewater Engineers Group

(PWEG)

Study Financed by Centre of Environmental Health Activities
CEHA-WHO, Amman-Jordan

Ramallah
January 2005

Pre-Feasibility Study

Pre-Feasibility Study on the Rehabilitation of Jenin Wastewater Treatment Plant

Palestinian Wastewater Engineers Group (PWEG)

Ramallah, January 2005

The Palestinian Wastewater Engineers Group (PWEG) was established in 2003. It is a non-governmental, non-profit making wastewater organization. PWEG is the only Palestinian non-governmental organization dedicated completely and solely to wastewater. PWEG aims to enhance the wastewater sector in Palestine. PWEG is located in the West Bank city of Al Bireh.

Special Thanks

PWEG would like to thank the World Health Organization, Regional Office For The Eastern Mediterranean, Regional Centre For Environmental Health Activities (CEHA) for supporting and financing this pre-feasibility study. PWEG thanks Dr. Zaki Ali Khan and Dr. Saqer Al Salem for their generous contribution and support. PWEG thanks also Dr. Nidal Mahmoud, Eng. Waddah Al Labadi and Eng. Sameeh Al Ahmad for supporting the study.

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Section 1

1. General.

1.1 Authorization:

Jenin Municipal Council had contracted the Palestinian Wastewater Engineers Group (PWEG) on 24th November, 2004 to perform a pre feasibility study on the rehabilitation of Jenin Wastewater Treatment Plant (JWWTP).

Jenin Municipal Council is financially supported for conducting the pre-feasibility study by the World Health Organization (WHO), Regional Centre for Environmental Health Activities (CEHA) Amman.

1.2 Study Area:

The City of Jenin is located in the northern part of the West Bank close to the 1967 borders, and is one of the most important urban centres of north Palestine. The study area as per the Terms of Reference (TOR) is limited to Jenin City and its Wastewater Treatment Plant (WWTP), figure no. 1.1 presents location map for Jenin.

The city is characterized by condensed high rise buildings and is about to be saturated by residential buildings. The topography of Jenin area consists of hills with moderate slopes and flat areas. The total Municipal area is 11000 donums of which an area of 7000 donums is considered to be as built area.

Jenin is situated at 104 meters above mean sea level. Similar to other Palestinian cities, the military occupation of the city since the year 1967 had almost halted the city urban development. As of the political and military crisis, ongoing since September 2000, the blockade and belligerent military actions have severely impacted the city physical infrastructure and the municipality services. The municipal solid waste dumping site has been closed due to mobility hindrance and alternatively, the solid waste is dumped in the wastewater treatment plant.

1.3 Population:

The total population of the city of Jenin in addition to the refugee camp is estimated at 45000 inhabitants, of which 13000-14000 are in the refugee camp based on the municipality information. The rate of population increase including natural growth rate, rural exodus and returnees is 4% per annum. The population in Jenin governorate had been estimated at 252813 inhabitants (Palestinian Central Bureau of Statistics, Palestine in Figures, May 2003). The population is working mainly in agriculture cultivating plains around the city and Marj Ibn

Amer. Jenin is one of the most affected Palestinian cities due to the ongoing conflict, Israeli closures, curfews and construction of the separation wall has seriously affected the economy of the population. The number of population depending on humanitarian assistance is growing. Almost 40% of the population are facing particular hardship and are food insecure. They rely on assistance, mostly food, to supplement their incomes (Consolidated Appeal Process, United Nations Office for the Coordination of Humanitarian Affairs, 2004). Industrial activities which were promoted during Oslo era are heavily affected where different industrial activities had been collapsed. Jenin industrial city, with corner stone laid by his Excellency Mr. Rau (former German President) was completely stopped.

1.4 Climate:

Jenin is dominated by Mediterranean climate which has four months (from May to October) of hot dry summer and a winter with rain from November to April. The climate can be characterized as hot and dry during the summer and cool and wet in winter. The minimum temperature in winter is 9 oC. The average annual rainfall is 530 mm. Prevailing wind directions lies between southwest and northwest.

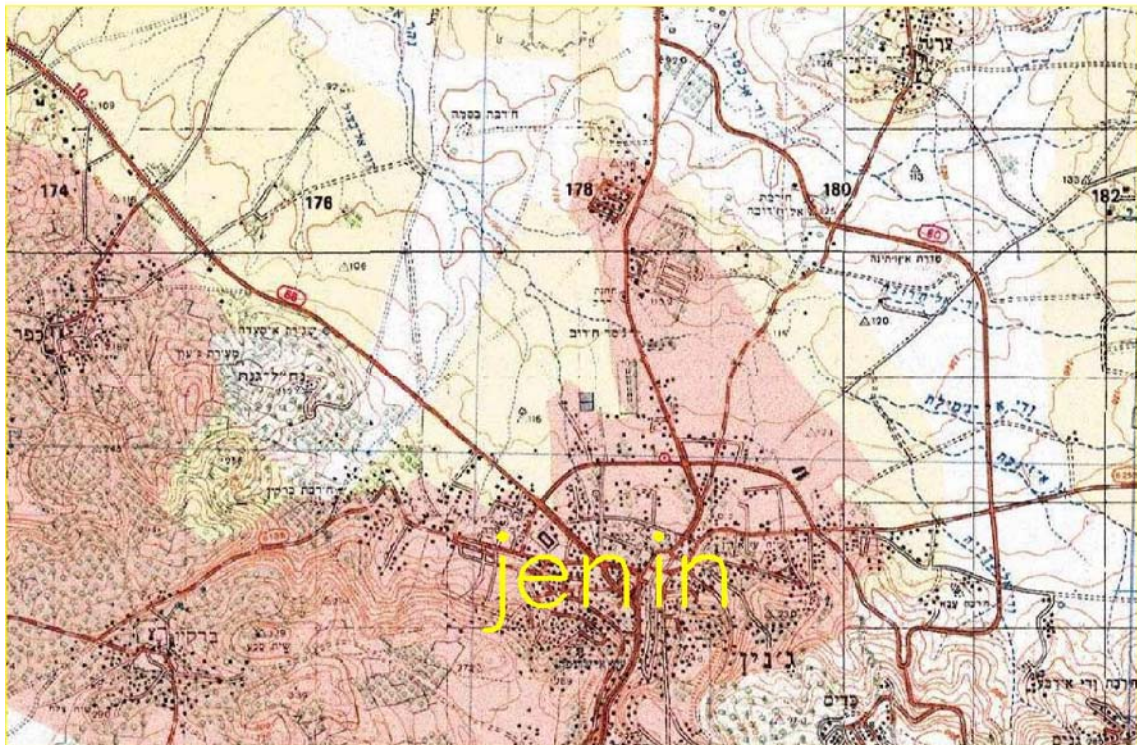


Figure 1.1 Jenin Location

Section 2

2. Water Services:

The principle water resources available to Palestinians include groundwater, springs and harvested rainwater. Jenin relies on ground water extracted from its own wells where water services is responsibility of the Municipality. Water is supplied from wells owned by the Municipality, such as well number one and well of Haifa street as well as other wells owned by the Palestinian Water Authority such as Arraba, Qabatia and Jaba' well which is the biggest supplying 35 Palestinian villages and communities such as Yabad and Ajja. Jaba' Well supplies also Israeli settlements and military camps. The Israeli Water Company (Mekorot) contributes to water supply. Jenin municipality is supplying water to more than 35 Palestinian villages, towns and cities such as Yabad, Kufor Rai, Qamha' and Ajja. Very low level of water fees collection ratio is reported where the community suffers poverty and low level of enforcement of the law. Water analysis is made regularly by the municipal Water and Sanitation Operation Centre where 32 employees between Engineers, technicians and non skilled workers are working. Except an isolated case of water pollution during the invasion of Jenin Refugee Camp, no water pollution in the water network or water wells is reported. According to the municipality water and wastewater engineers, the specific water consumption is 80 L/c.d. Average yearly water supply is 1,552,298.00 cubic meter and the yearly average metered water is 946,702.00 cubic meter where water losses are high. Water production from municipal wells is insufficient and the deficit is supplied through Mekorot.

The drinking water network covers 95% of Jenin city where few kilometres of the network has been recently implemented with international financial support. Number of installed water meters is 6122. An increase of 1L.c.year is recommended for future design over the coming 25 years caused by the presumed increase in the living standards. No as built drawings for the water network are available which hinders operation and maintenance works which are intensive due to the old network and to the repeated and frequent invasions of the city?

Table 1 : Present drinking water consumption of Jenin city and refugee camp

| Locality | Population | Specific water consumption | Total water consumption |
|------------|------------|----------------------------|-------------------------|
| | # | (L/c.d) | (m ³ /d) |
| Jenin City | 30,000 | 80 | 2400 |
| Jenin Camp | 15,000 | 80 | 1200 |
| | | | |

⁺ Consider 80% of the consumed water return as wastewater

Section 3

3. Wastewater

3.1 Wastewater network:

The sewerage network of Jenin is very old as it was constructed during the last century. Until the establishment of the water and wastewater operation centre, the sewerage network was maintained and extended with almost no preparatory study. The sewerage network was partly rehabilitated in 1993. The network is not constructed according to proper engineering norms. For instance, large sewers diameters are followed by sewers of smaller diameters, and others are laid at inverse slope. 40% of Jenin's population and 100% of the Jenin Refugee camp population are connected to the wastewater network.

The sewerage network of Jenin city has an approximate length of 50 km. A large portion of the network is old, undersized and/or broken. The network consists of different kind of pipes and diameters which had been constructed through the years starting from the Ottoman era till today. Diameters starting from 4 inches pipes to 20 inches are existing, very old close channel network from the early Ottoman era are found in the old city centre, concrete pipes, steel pipes, vitrified clay pipes, pvc pipes, Upvc and asbestos pipes are used in the construction of the city wastewater network. No as built drawing is available. The roofs of the houses are illegally connected to the sewerage network although it is designed and constructed as separate but not combined network. The Only 40% of the population of Jenin Municipality is served with the sewerage network, and the remaining 60% use cesspits. Septage from the cesspits is improperly disposed in open areas where it threatens public health, environment and compromises groundwater quality, particularly of the shallow aquifer. This necessitates the rehabilitation and expansion of the sewerage network and the treatment plant.

3.2 Wastewater Characteristics:

The review of previous studies, analysis and literature on wastewater analysis revealed that, wastewater quality fluctuates from time to time. The recent analysis made on December 2004 is most reliable and is considered for further calculations. Wastewater of Jenin city is very concentrated as shown in the following Table, due to low water consumption. However, the specific water consumption is 80l/c.d (estimation by Municipality Water Engineers based on metered water), wastewater return value of 80%, and the BOD values is 1100 mg/l and 1182 mg/L from Table 2, the specific BOD production is 70 g/c.d and 76 g/c.d which is higher than the international value of 60 g/c.d.

Table 2 Wastewater characteristics of Jenin city (PECDAR, 1994), municipality 1995, 1999, PWEG 2004, all units are in mg/L

| | PECDAR, 1994 | Municipality, 1999 | PWEG, 2005 |
|----------|--------------|--------------------|------------|
| BOD mg/L | 1100 | 1182 | 1100 |
| COD mg/L | 1440 | 2020 | 1700 |
| pH | 7.5 | 6.95 | 6.90 |
| TS mg/L | - | | 4150 |
| TSS | 1088 | 1290 | 805 |

3.3 Wastewater Treatment Plant:

The Wastewater treatment plant WWTP of of Jenin was constructed in 1972 west of the city. The WWTP consists of two aerated lagoons in series followed by a polishing pond (figure 4.1). One time the first lagoon was equipped with four surface aerators and a mixer, and the second lagoon was equipped with two surface aerators and no mixer. Only the first aerated lagoon is completely lined (banks and bottom), while of the second lagoon only the bottom is lined, and all sides of the stabilisation pond are not. The unlined basins are potential source of groundwater pollution as wastewater might seep. The treatment facilities have a design capacity of 760m³/d. The existing three ponds have a total surface area of 3120 m². The total area of the treatment plant land is 23,000 m². The plant has not been operating effectively since sometime. Last rehabilitation of the plant was made in the year 2000 as among others the aerators were broken and was financed by the previous Israeli Civil Administration which allocated 750000 NIS for it's rehabilitation. The rehabilitation works included the provision of the first aerated lagoon with four surface aerators and one mixer, and the second aerated lagoon was equipped with two surface aerators. Unfortunately, the six aerators, the mixer and the electricity cables were stolen during the last political unrest in the country. The rehabilitation works in the year 2000 aimed at complementing the shortages and faults existing since the erection of the WWTP in the year 1972. The treatment plant used to suffer from three main problems:

1. Wastewater is conveyed to the treatment plant by two main trunk lines, one from Jenin city and the other from the refugee camp. The refugee camp sewer line is located below the level of the screen which causes frequent flooding and inundation of the treatment area.
2. There was no by-pass line, but was constructed in the year 2000.

3. The mechanical bar-screen was never operational, so it was repaired in the year 2000, but even after being rehabilitated the screen did not function.



Bar Screen Unit at Jenin WWTP

In addition to tackling the previous, the year 2000 rehabilitation works included:

1. Cleaning of the site as well as desludging of the polishing pond as the sludge height was 80 cm, and was never removed since the construction of the WWTP in the year 1972.
2. Supply and erection of effluent Lamella structure in the polishing pond and sludge recirculation pump station.
3. Supply and erection of all electromechanical equipment for recirculation pump station, including all accessories.
4. Control transformer and various electrical installations and erection of lightening system.

Nowadays, the plant is destroyed and till few weeks ago was used as solid waste dumping site where the municipality due to curfews and due to limitation of movement of it's solid waste collection trucks was obliged to use the plant as a temporary solid waste dumping site, the current Israeli–Palestinian conflict have seriously affected the municipality capacity in running the WWTP.

The connecting road of Jenin city to the wastewater treatment plant of 0.6 km length is destroyed and needs to be rehabilitated. Wastewater flows westward bypassing the treatment plant without any kind of treatment.

Untreated wastewater flows westward into Wadi Al Muqatta' (see below photo). Groundwater table in this area is very shallow (50-100 meters deep), ground water here is most probably polluted, leachate from the solid waste accumulated at the plant site contributes to further pollution of the groundwater.



Wastewater from Jenin and Refugee Camp flowing into Wadi Al Muqatta'

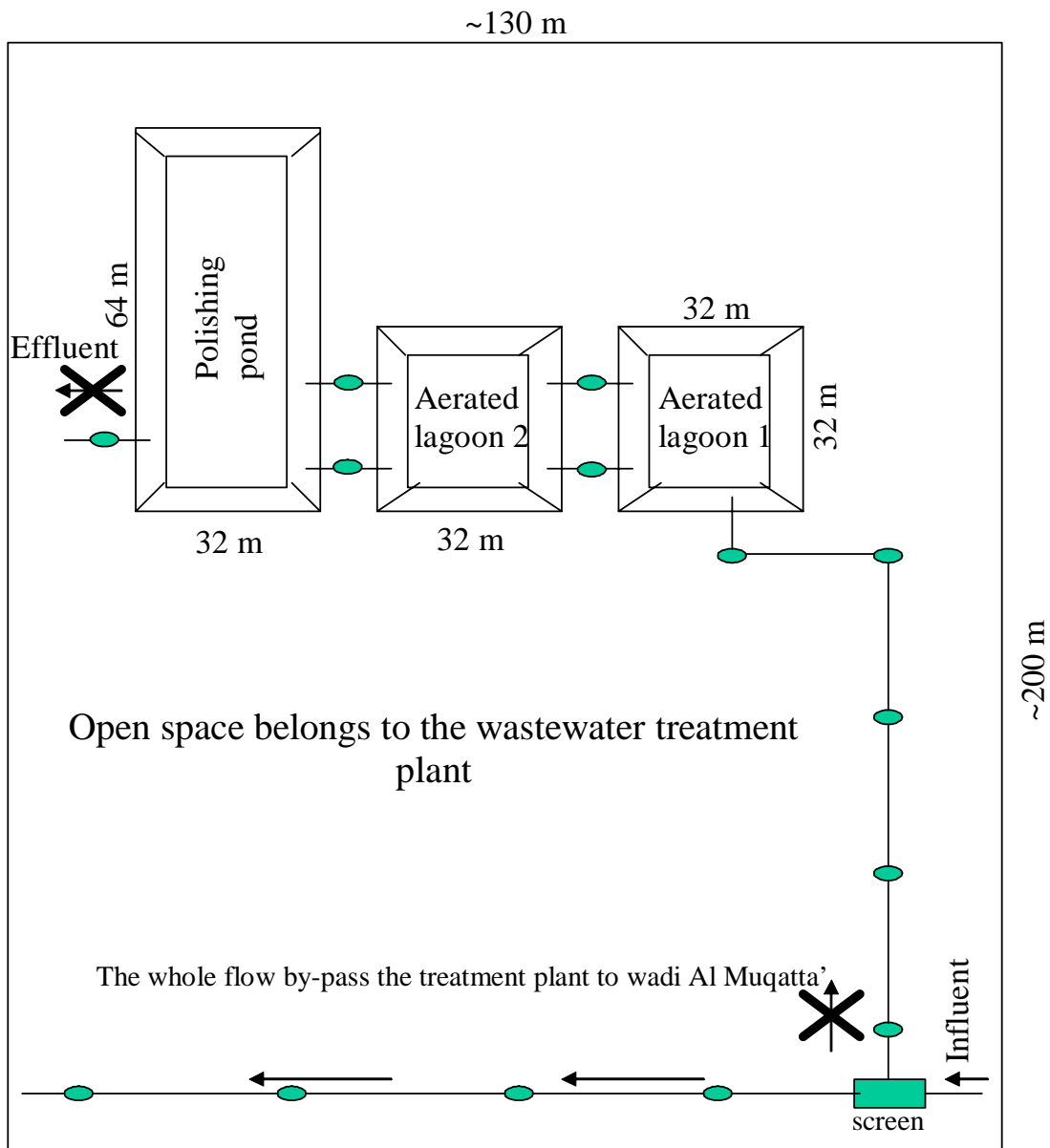
Palestinian farmers have drilled 50 water wells on both sides of the Wadi. Last wastewater analysis was made at the end of the year 2000, no wastewater analysis is made any more. Houses have been permitted to be constructed near

the boundary of the wastewater treatment plant, which is usually not permitted by normal land use planning in order to abate health hazards.



Jenin WWTP





(Figure 4.1): Flow scheme of the existing Jenin WWTP

Section 4

4. Performance of the WWTP:

The wastewater treatment plant of Jenin is currently not operational, and even is out of service.

The dimensions of the existing ponds as have been read from the existing maps are in the table below.

Table 2: Dimensions of the existing WWTP in Jenin

| [†] Dimensions | Aerated lagoon 1 (AL 1) | Aerated lagoon 2 (AL 2) | Polishing pond |
|--------------------------------|----------------------------|----------------------------|----------------|
| Width (m) | 27 | 26 | 26.75 |
| Length (m) | 28.5 | 28.75 | 57.5 |
| Depth (m) | 3.8 | 3.6 | 3.3 |
| Surface area (m ²) | 770 | 750 | 1540 |
| Volume (m ³) | 2926 | 2700 | 5082 |

[†]dimensions measured from AutoCAD drawings (source municipality); the dimensions are the working dimensions.

The performance of the aerated lagoon is described by the following equation:

$$\frac{S_e}{S_i} = \frac{1}{k \times t + 1}$$

where

S_e: effluent BOD

S_i: influent BOD

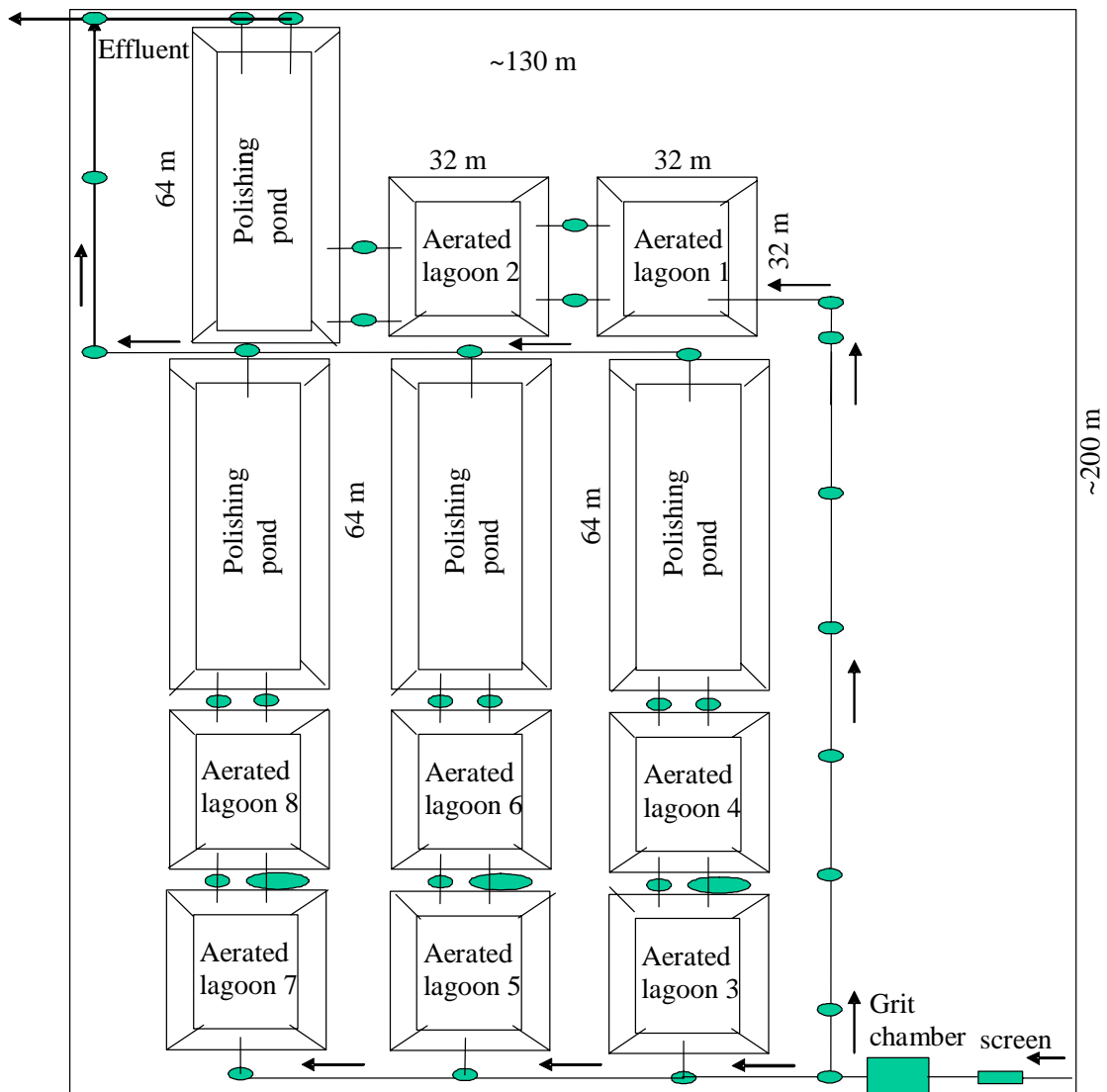
t: hydraulic retention time (d); $t = V/Q$, V is the volume in m³, and Q is the flow rate in m³/d

k: the overall first order BOD removal rate (d⁻¹); for Jenin considering the winter temperature 0.62 d⁻¹

Based on the data given in (table 3) and the design equation, the effluent of the aerated lagoons is 280 mg/L BOD. The surface load on the polishing pond is 950 kg BOD/ha.d. According to Arceivala (1973), the surface loading value used in Israel is in the range of 130-150 kg BOD/ha.d for polishing and facultative ponds. A surface loading rate greater than this range will turn the pond anaerobic.

The surface loading of the polishing pond is about 20 times higher than this value. The calculated figures show that Jenin WWTP is far overloaded, and urgent extension of the plant is essential.

Considering the current collected wastewater, additional three folds of the existing treatment plant should be constructed. As the coverage of the sewerage network might increase before implementing the regional Wastewater Treatment Plant, additional 5% coverage, in total 45%, is considered. In this case additional three folds of the existing treatment plant should be constructed as shown in Figure (5.1). In this case, the BOD in the aerated lagoons effluent will be 50 mg/L. The surface loading will be 148 kg BOD/ha.d, which is in the range of 130-150 kg BOD/ha.d. The effluent of the polishing pond will contain a BOD value of 20 mg/L. But since the pond will function as a facultative pond, algal concentration in the effluent will be high, and the BOD value will exceed the calculated 20 mg/L, and so the 20 mg BOD/L is of filtered sample.



(Fig. 5.1) Layout of the emergency plan for upgrading the WWTP of Jenin to cope with current collected wastewater

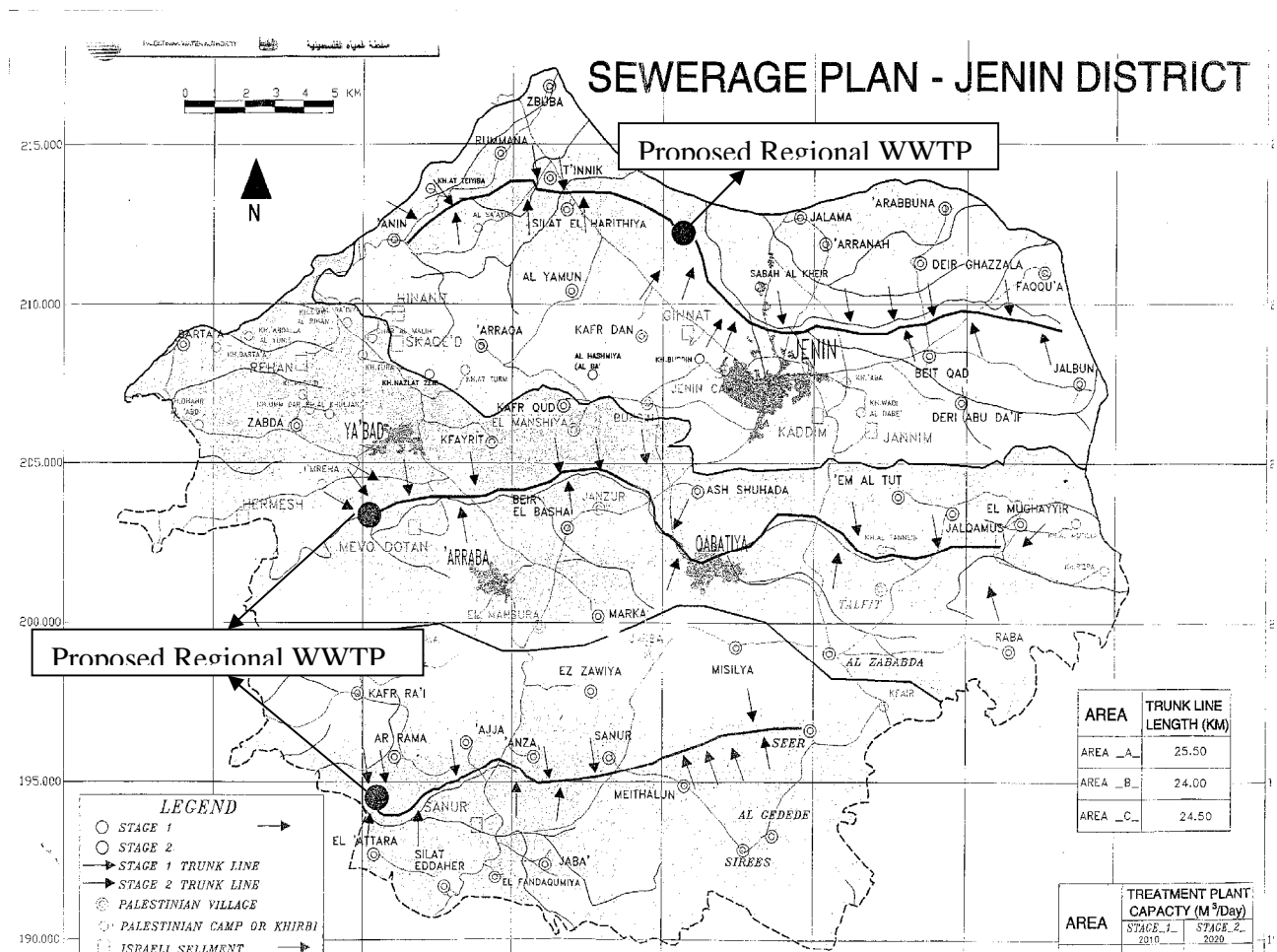
Section 5

5. Planning for future developments:

The municipality of Jenin and prior of the ongoing conflict was in an advanced phase regarding the planning of a completely new wastewater treatment plant which was supposed to be a regional wastewater treatment plant serving Jenin,

Jenin Refugee Camp and other 13 villages, the Israeli area of Jilboa' and Jenin proposed industrial zone were supposed to be served by this treatment plant also. The proposed plant represents a proper and sustainable ultimate solution for the treatment of Jenin Wastewater since the location of the present WWTP is no more suitable and does not satisfy future needs and city development.

Additional two wastewater treatment plants (see below plan) were planned to tackle the treatment and reuse of the whole wastewater generated in Jenin governorate including major communities such as Ya'bad, Qabatia and Arraba. Now a day, Jenin municipality aims to the rehabilitation of the existing WWTP as an emergency and temporary solution.



Section 6

6. Rehabilitation Works:

Jenin WWTP needs more reconstruction rather than rehabilitation. The WWTP is out of service since four years, pre-treatment unit (bar screen) had never been in operation since the construction of the WWTP, surface aerators as well as all other electromechanical equipment are missing, wastewater is completely by passing the WWTP flowing directly into Wadi Al Muqatta'. The (rehabilitation) of the existing lagoons and pond will not provide enough wastewater treatment and the effluent will remain over all international characteristics and standards and will still represent a threat to environment, health and groundwater, since the WWTP will be largely over loaded, in addition, no additional connection to the wastewater network will be allowed.

The WWTP needs a combination of both, rehabilitation of existing facilities such as by pass pipeline and administration and operation building, and reconstructing new major components such as ponds and lagoons and pre-treatment unit with all needed electromechanical and finishing works. In this case, original lagoons and pond must be shifted and reconstructed to allow reconstruction of additional needed ponds and lagoons as well as a pre-treatment unit consisting of two bar screen units, grit removal chamber and a venturi meter channel for influent measurement.

(Rehabilitation) of Jenin WWTP consists mainly in minor works and major works, minor works are the removal of accumulated solid waste hips, construction of internal roads, rehabilitation of the road which connects Jenin city to the WWTP, rehabilitation of the existing operation building, rehabilitation of the by-pass and construction of lightening system.

Major works are divided into two categories which are the civil works and the electromechanical works, the civil works includes the construction of five folds of lagoons and ponds and civil structure of a pre- treatment unit consisting of two mechanical bar screens, grit removal chamber and a Venturi channel. The electromechanical works include the supply and installation of surface aerators, submersible mixers, mechanical bar screens, sluice gates; stand by electricity diesel generator and all needed electro mechanical equipment and accessories such as cables, pumps and electrical control panels.

Section 7

7. Cost Estimate

Minor Civil Works:

| No. | Description | Unit | Quantity | Unit Price (NIS) | Total (NIS) |
|-----|---|----------------|----------|------------------|-------------|
| 1. | Removal of solid waste by transporting it from the site of the WWTP to the Municipal dumping site. | M ³ | | | |
| 2. | Excavation and leveling of the sub grade to the widths and levels of the proposed horizontal & vertical alignment for the internal roads of the WWTP, using the suitable excavated materials for backfilling and disposing off the site the unsuitable and surplus excavated materials. | M ³ | | | |
| 3. | Backfilling of base coarse, works include supply and install of 25 cm compacted base coarse. | M ³ | | | |
| 4. | Supply and lay compacted asphalt layer containing 5.5%of bitumen, 6 cm thick and ¾ inch (aggregate size), after spraying the base coarse with MCO at the rate of 1 kg per square metr. | M ² | | | |
| 5. | Rehabilitation of the existing operation building, works includes rehabilitation of Toilets, guard room, electrical panels room, electrical transformer room, workshop and kitchen. | L.S | | | |
| 6. | Rehabilitation of the by pass, works includes reconstruction of manholes, cleaning and flushing of existing pipe line. | L.S | | | |
| 7. | Construction of lightening system | L.S | | | |

Sub. Total: 598.000 NIS

Major Civil Works:

| No. | Description | Unit | Quantity | Unit Price (NIS) | Total (NIS) |
|-----|---|------|----------|------------------|-------------|
| 1. | Emptying and cleaning of the existing ponds and lagoon and disposing of the excavated material at the Municipal dumping site. | L.S | | | |
| 2. | Excavation of ponds and lagoons to the required dimensions and disposing of site of the excavated material. | M3 | | | |

Major Civil Works:

| No. | Description | Unit | Quantity | Unit Price (NIS) | Total (NIS) |
|-----|--|----------------|----------|------------------|-------------|
| 3. | Supplying and laying of an isolation membrane. | M ² | | | |
| 4. | Supplying, laying and compaction of base coarse layer (30cm) at the bottom and sides of ponds and lagoons. | M ³ | | | |
| 6. | Constructing of civil structure for a pre-treatment unit consisting of two mechanical bar screens, grit removal chamber and a Venturi channel. | L.S | | | |

Sub. Total: 1.199.000 NIS**Major Electromechanical works:**

| No. | Description | Unit | Quantity | Unit Price (NIS) | Total (NIS) |
|-----|---|------|----------|------------------|-------------|
| 1. | Supply and installation of surface aerators, submersible mixers, mechanical bar screens, sluice gates; stand by electricity diesel generator and all needed electro mechanical equipment and accessories such as cables, pumps and electrical panels. | L.S | - | - | |

Section 8

8. Conclusions and recommendations

- Jenin WWTP is completely out of service since four years; the WWTP is overloaded and can not cope with the present collected wastewater from the city (40%) and from the Jenin refugee camp (100%).
- For the WWTP to be able to handle the current flow, it should be expanded by additional three folds the existing scheme and constructing a pre-treatment unit. This is important as an emergency measure to protect the environment and the public health as well as groundwater.
- In all cases, the WWTP should be equipped with a new screen and grit removal chamber and an influent measurement device.
- The existing polishing pond is short circuited as the influent and effluent points are at the same line on the short side of the pond.
- The location of the existing treatment plant is not suitable for treatment of the whole present neither the future wastewater generated from Jenin city due to municipal urban area expansion adjacent to the treatment plant.
- Identifying new locations for wastewater treatment plant outside the city is essential; the proposed three regional wastewater treatment plants represent a very good idea for the treatment of Jenin wastewater as well as the whole wastewater generated in Jenin Governorate.
- The construction and rehabilitation of the existing wastewater treatment plant must be accompanied with the training of future operation and maintenance staff.
- Preparation of as built drawings for the sewerage network is highly recommended.
- For future plans and considering the high concentration of BOD (1100mg/L), anaerobic treatment prior to aerobic systems is recommended.
- Rehabilitation works must be combined with a wastewater reuse strategy where treated wastewater must be reused in irrigating neighbouring large agricultural area.

Section 9

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